

## REMARKS

Claims 1-13, 17-24 and 31 are pending in the application.

### Allowable Subject Matter

The applicants are pleased to note that the Office Action advises at page 3 that claims 1-13, 17-19 and 21-24 are allowed.

### §103

Claims 20 and 31 were rejected under 35 U.S.C. §103(a) as being unpatentable over Japan No. 09-103849 in view of U.S. Patent No. 4,887,662 to Tanaka et al.

This rejection is respectfully traversed.

### The Present Invention

#### Claim 20

#### Features Of Claim 20

1. The present invention of Claim 20 is characterized by:

1(a) dimples 40 to 200  $\mu\text{m}$  in average depth and 0.5 to 3 mm in diameter of circle equivalent, adjacent to each other at the rims of said dimples (refer to Fig. 6), and

1(b) a film containing a substance more excellent than Ni in wettability with scum.

In addition, both the dimples and the film are formed on the plated peripheral surface of the cooling drum.

### Effects Based On The Features of Claim 20

The feature "1(a)" has an effect to disperse stress and strain exerted on a solidified shell, and as a result, to reduce the macroscopic stress and strain exerted on the solidified shell (refer to specification, lines 8 to 11 on page 66 in the description).

The feature "1(b)" is the important one based on the finding (C) (refer to lines 28 to 31 on page 19 and line 15 on page 63 to line 1 on page 64) and has a significant effect not to generate solidification unevenness that induces "pickling-unevenness accompanying crack" (refer to specification, line 2 to 10 on page 64 and Table 6 on page 71).

According to the synergy between the feature "1(a)" and the feature "1(b)", Claim 20 has the significant effect that a thin slab produced by using Claim 20 does not have "surface defects" such as "surface cracks and crevices", "pickling unevenness", and "pickling-unevenness accompanying cracks" (refer to lines 13 to 16 on page 98).

### Patentability

In support of the patentability of claim 20, the applicants submit the following documents as Exhibit A and Exhibit B to rebut the positions taken in the Office Action mailed November 18, 2003.

Exhibit A - Reference (1). Progress In Surface And Membrane Science, Vol. 14, Ed. D.A. Cadenhead et al., "The Wettability Of Solids By Liquid Metals", J.V. Naidich, pp. 353-484, 1981 - Ref. (1).

Exhibit B - Reference (2). Steel Research 60

(1989) No. 3 & 4, "Calculation Of The Interfacial Properties Of Liquid Slag", A.W. Cramb et al., pp. 157-165 - Ref. (2).

Feature 1(b) of claim 20, i.e., "a film containing a substance more excellent than Ni in wettability with scum", is submitted not to be obvious over a Co layer formed on the peripheral surface of drum over a Ni layer as disclosed in JP `649. The Office Action at page 2 cites JP `849, particularly abstract and Figures.

The Office Action takes the position at page 4, lines 12-14 that one of ordinary skill in the art would understand that the cobalt coating would form a film that is more wettable with scum than nickel. The applicants respectfully disagree.

This position of the Office Action is based upon the assertion that (x) cobalt oxidizes more readily than nickel and (y) one of ordinary skill in the art understands that oxides are more compatible with scum and oxides than pure metals are. See Office Action page 4, lines 10-12.

Applicants maintain that assertion (y) is not correct.

Table 1 of Ref. (1) at pages 386-387 shows the wettability of various oxides (solids) by liquid metals. See  $\theta$  in Table 1.  $\theta$  {contact (wetting) angle ( $^{\circ}$ )} is an indicator for wettability.

Most  $\theta$ s in Table 1 of Ref. (1) are more than  $90^{\circ}$ . This means most oxides (solids) are not wettable with liquid metals.

On the other hand, the Table at page 455 of Ref. (1) shows that wetting or contact angels in metal-metal systems are less than  $90^\circ$  (see Wetting angle,  $^\circ$ ). See also Table 20 at page 463 of Ref. (1)  $0^\circ$  Zn-Me,  $0^\circ$  Cd-Me and  $0^\circ$  Sn-Me.

For example, in Table 20 at page 463 of Ref. (1),  $\theta$  is  $0^\circ$  in the metal-metal system Cd-Ag as compared to  $\theta$  is  $112^\circ$  in the CdO-Ag system at No. 52 in Table 1 at page 387 of Ref. (1). This means that Cd (solid) is more wettable with Ag (liquid) than CdO (solid).

Thus, in the case of a metal and an oxide of the metal, it is not understood by one skilled in the art that the oxide of a metal is more wettable with liquid metals than the pure metal.

Therefore, it is clear that one skilled in the art cannot understand that oxides of a metal are more wettable with a liquid metals than pure metals.

Ref. (2) at Table 3 at page 158 shows contact angles (wettability) of various liquid slags in contact with solid surfaces.

According to Table 3 of Ref. (2), it cannot be understood by one skilled in the art that contact angles of various liquid slags in contact with surface of alumina, zirconia or magnesia (solid oxides) are absolutely smaller than the contact angles of various liquid slags in contact with surface of iron or steel (solid metals).

That is, one of ordinary skill in the art cannot readily understand that oxides are absolutely more wettable with liquid slags than solid metals are.

As a result, it can be concluded that, in both cases of liquid metals and slags contacted with solid surfaces of a metal and an oxide, the relative relationship of wettability of the metal and the oxide cannot be absolutely decided by based on the fact that the solid substance contacting with the liquid metal or slag is either a metal or an oxide.

According to the above, it is clear to one of ordinary skill in the art that, in a case of scum, which is something like liquid slag, the relative relationship of wettability of the metal and the oxide cannot be absolutely decided based on the fact that a solid substance contacting with the liquid metal or slag is either a metal or an oxide.

Therefore, as explained above, it is submitted that assertion (y) is not correct according to Ref. 1 and Ref. 2.

Accordingly, it is clear that one of ordinary skill in the art cannot understand that the cobalt coating of JP `849 forms a film that is more wettable with scum than nickel.

The Co layer formed on the Ni layer disclosed in JP `849 (refer to abstract and figure) does not disclose or suggest feature 1(b) of claim 20, that is, "a film containing a substance more excellent than Ni in wettability with scum".

As explained above, feature 1(b) of claim 20 is the important feature based on finding (C) (refer to

specification lines 28 to 31 on page 19 and line 15 on page 63 to line 1 on page 64), and has the significant effect of not generating solidification unevenness that induces "pickling-unevenness accompanying crack" (refer to specification line 2 to 10 on page 64 and Table 6 on page 71).

US `662 discloses or suggests nothing related to the wettability of feature 1(b) of claim 20.

Accordingly, JP `849 and/or USP `662 do/does not disclose or suggest the present invention of claim 20.

Therefore, claim 20 is patentable.

### Claim 31

#### Features Of Claim 31

2. The present invention of Claim 31 is characterized by:

2(a) the thermal conductivity of the base material of the drum being not less than 100 w/m·k;

2(b) an intermediate layer 100 to 2,000  $\mu\text{m}$  in thickness having the coefficient of thermal expansion of 0.50 to 1.20 times that of said drum base material and Vickers hardness Hv of not less than 150 being coated on the surface of said drum base material;

2(c) a hard plated layer 1 to 500  $\mu\text{m}$  in thickness having Vickers hardness Hv of not less than 200 being applied on the outermost surface;

2(d) dimples 200 to 2,000  $\mu\text{m}$  in diameter and 80 to 200  $\mu\text{m}$  in depth being formed so as to contact each other or be adjacent to each other on the surface; and

2(e) fine holes on the surface which are 50 to 200  $\mu\text{m}$  in diameter and 30  $\mu\text{m}$  or more in depth being formed so as to have the pitch of 100 to 500  $\mu\text{m}$  but not to contact each other.

**Effects Based On The Features Of Claim 31**

The feature "2(a)" has an effect to suppress the generation of thermal stress by maintaining the temperature of the drum low, and as a result, to prolong the service life (refer to specification, lines 11 to 15 on page 72).

The feature "2(b)" has an effect to prevent the peeling off of the intermediate layer by reducing the shearing stress attributed to thermal stress caused by the difference in the coefficient of thermal expansion between the intermediate layer and the drum base material (refer to lines 18 to 25 on page 72), an effect to prolong the service life by maintaining both deformation resistance and toughness required of the intermediate layer (refer to lines 1 to 7 on page 73). Another effect is to protect the drum base material thermally by avoiding the excessive rise of the surface temperature of the intermediate layer (refer to lines 8 to 13 on page 73).

The feature "2(c)" has an effect to maintain the abrasion resistance required of the outermost surface (refer to specification, lines 22 to 30 on page 73).

The feature "2(d)" has an effect to make the solidification-contraction stress dispersed and relaxed by the generation of solidification nuclei, and as a result, to suppress the occurrence of cracks and uneven luster on a thin

slab (refer to lines 6 to 20 on page 74, line 32 on page 74 to line 17 on page 75 and Figs. 21 and 22).

The feature "2(e)" is unique to the present invention and has a significant effect to suppress the occurrence of unevenness of the solidification even at the portions where scum was carried in (refer to line 18 on page 75 to line 34 on page 76 and Figs. 21 to 22).

According to these features, especially both the feature "2(d)" and the feature "2(e)" which have a close relationship in view of diameter (refer to line 32 on page 74 to line 4 on page 75), Claim 31 has the significant effect that a thin slab produced by using Claim 31 does not have "surface defects" such as "surface cracks and crevices", "pickling unevenness", and "pickling-unevenness accompanying cracks" (refer to Table 7 on page 80 and lines 13 to 16 on page 98).

#### **Patentability**

In the present invention of claim 31, the dimples and the fine holes are formed on the surface of the drum as shown schematically in Fig. 21 and Fig. 22 (refer to dimple 16, fine hole 19, drum base material 20, intermediate layer 21 and outermost surface 22 in the figure, and specification line 1 on page 73 to line 15 on page 79, and Table 7 on page 80).

The present invention of claim 31 has a significant effect based on the features 2(a) to 2(e) as explained previously.



Among the features 2(a) to 2(e), the feature 2(e), which is further formed on the drum surface formed by the feature 2(d) (refer to Fig. 21 and Fig. 22), is the unique one and has a significant effect to suppress the occurrence of unevenness of the solidification even at the portions where scum is carried in (refer to specification line 18 on page 75 to line 34 on page 76 and Figs. 21 to 22).

According to these features, especially the synergy of both the feature 2(d) and the feature 2(a) formed on the drum surface, which have close relationship in view of diameter (refer to specification line 32 on page 74 to line 4 on page 75), the present invention of claim 31 has a significant effect in that a thin slab does not have "surface defects" such as "surface cracks and crevices", "pickling evenness", and "pickling-unevenness accompanying cracks" (refer to Table 7 on page 80 of the specification and lines 13 to 16 on page 98).

In addition, a drum surface providing both the feature "2(d)" and the feature "2(e)" can be formed by shot blasting and laser material processing (refer to specification line 35 on page 76 to line 4 on page 77 and lines 12 to 17 on page 77).

Furthermore, as explained in the response to the previous Office Action, JP `849 does not disclose or suggest the feature 2(d) and the feature 2(e) formed on the drum surface, and furthermore the synergistic effect of both the feature 2(d) and the feature 2(e), because no technical matters related to wettability with scum or formation of fine hole as described in JP `849.

Also, from the view point of the existence mode of dimples on the surface of cooling drum, the dimples disclosed in USP `662 are different from the "fine holes" characterized by the feature 2(e). Therefore USP `662 does not disclose or suggest the existence mode and function of the "fine holes" required by feature 2(e).

USP `662 does not disclose or suggest the problem caused by synergy between the dimples and the scum, or any technical matters resolving the problem, for example, the technical matter such as the synergistic effect of both feature 2(d) and feature 2(e).

As explained above, it is clear that the location for "the fine holes" is clearly defined in the feature 2(e) though the Office Action maintains that claim 31 does not cite locations for the fine holes.

JP `849 and/or USP `662 do/does not disclose or suggest feature 2(e) and the synergistic effect of both feature 2(d) and feature 2(e).

Accordingly, JP `849 and/or USP `662 do/does not disclose or suggest the present invention of claim 31 as explained above.

Therefore, claim 31 is patentable over USP `662 and/or JP `849.

CONCLUSION

It is submitted that in view of the foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that the application be allowed and passed for issue.

Respectfully submitted,

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